



Mission Operations Concept

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Operations concept Document

- **September 7, 2000 version available at:**
- **<http://glastproject.gsfc.nasa.gov/engn.htm>**



Target Of Opportunity Options

- **Level of optimization of initial TOO observation**
 - Handle TOO similar to burst detected onboard
 - Simple command to spacecraft for fixed duration observation
 - Spacecraft points in default direction during any earth occultation
 - Ground operators have option to develop more sophisticated observation during the initial fixed duration observation
 - Onboard process will have to check for occultation
 - Optimize initial observation
 - Design start time, duration, and any occulted pointing direction prior to commanding observation
- **MOC Staffing for command uplink**
 - Require operator to command TOO from MOC
 - Requires additional time (~ 1 hour?) for MOC operator to get to MOC when MOC is not staffed
 - Unstaffed commanding
 - Requires additional tools and processes in MOC and communications systems
 - Requires change to GSFC operations culture



TOO Timeline Guesstimate

	Op timized, Unstaffed Commanding	Op timized, Staffed Commanding	Unoptimized, Unstaffed Commanding	Unoptimized, Staffed Commanding
Generate Activity by PS or designee	45	30	5	5
MOC operator gets to MOC	0	60	0	60
Generate Commands from activity	5	30	5	5
Schedule Uplink	5	5	5	5
Send command and observe TOO	10	10	10	10
Total	65 minutes	135 minutes	25 minutes	85 minutes

Uplink scheduling at least 5 minutes; could be longer

Observe TOO time depends on distance to slew and visibility of target - could be shorter

SRD Requirement is 6 hours (4 hour goal)



Target Of Opportunity Frequency

- **Assumes TOO's will occur once per month after year one and less often in the first year**
- **More frequent TOO's could be a burden on the ops staffing as currently planned and might require a change in approach**
- **(chart reconstructed after the fact)**



Baseline Telemetry Downlink

- **[Pass timeline showing that there is enough time to dump the X-band data twice during a normal contact. This redundancy should reduce the amount of data loss. Assumes 300 kbps average rate from LAT]**
- **[Timeline showing passes for a typical day. Plenty of opportunities to recover data if a pass is missed; In addition, should be able to arrange ground stations so that data is not loss if the primary station is out for an extended period of time (hours)]**
- **[Current baseline is robust; Could increase average LAT data rate to ~750 kbps with only slight increase of data loss. Increases beyond 750 kbps would require more contacts per day and could drive ops costs in other ways.]**
- **[Reconstructed after the fact]**



Operations Drivers

- **Routine operations**
 - All-sky survey for first year
 - Pointed observations in subsequent years
 - Minimal pointing constraints
- **Real time operations**
 - Gamma ray burst alert
 - Autonomous interruption of current observation and/or slew of spacecraft for selected bursts; observe burst for 5 hours and return to interrupted operation
 - Transient detection alert
 - Anomaly alert
 - Targets of opportunity
- **Modest downlink volumes**
 - ~28 Gbits per day
- **South Atlantic Anomaly**
 - No instrument operations ~15% of the time

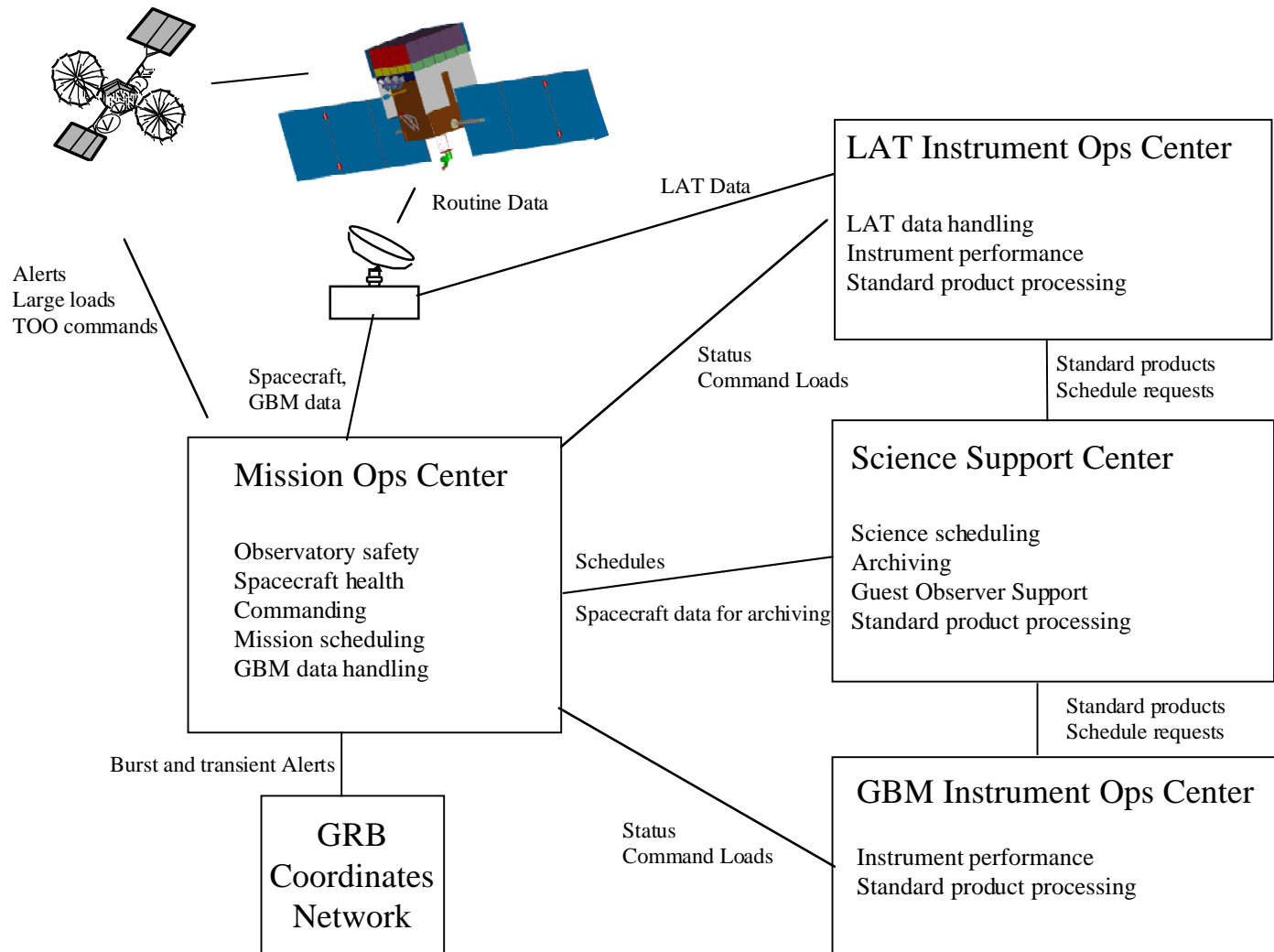


Operations Drivers (continued)

- **Long lifetime - 5 year requirement, 10 year goal**
- **Data Release**
 - Transients released immediately
 - Sky survey data available 3 months after completion
 - Guest observers have 3 months to validate data
 - Other data available within 2 weeks

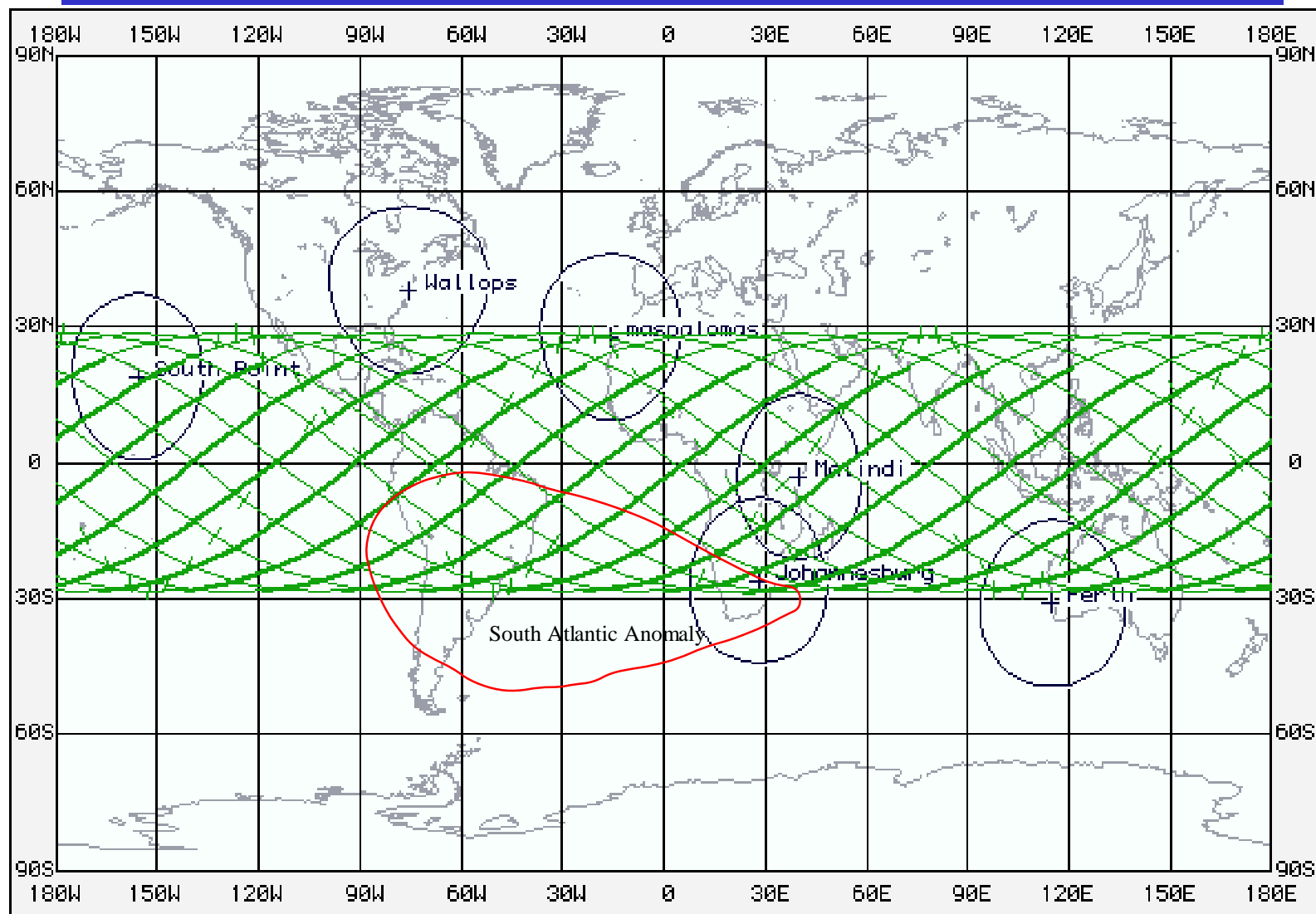


Reference Architecture





550 km 28.5° Circular Orbit





Space/Ground Communications

- **Onboard instrument processing significantly reduces LAT data volume**
 - 300 kbps average LAT data rate
 - GBM ~ 5 kbps
- **One contact per day through ground station for bulk science data**
 - ~28 Gbits
 - Solid State Recorder sized for 36 hours of data
- **Ground Station Network**
 - 11 meter X/S band antennas
 - Expect to have multiple opportunities per day for routine contact



Space/Ground Communications

- **Alerts through TDRSS Multiple Access System**
 - Demand access service provides 100% coverage
 - Supports requirements for 5 second end-to-end delay
 - 1 kbps
- **Large software loads for LAT (1 Mbyte or larger) through Single Access service at 4 kbps**
- **Target of Opportunity commands through MA or SA Forward service at 250 bps**
- **TDRSS also used to during launch and early orbit and anomaly resolution**



Routine Operations

- **Scheduling**
 - Ground station scheduling
 - Ground station provider schedules within GLAST specified window
 - Sky survey
 - SSC may adjust scan pattern periodically
 - Targets
 - Selected about once per year
 - Most will be long exposures - weeks to months
 - Two target mode - inertial pointing and pointed scan
 - Pointed scan keeps target within 30 degrees of instrument center
 - Instrument Activities
 - Instrument activities scheduled through the SSC
- **Commanding**
 - All commands are through the Mission Operations Center
 - Command loads once or twice per week
 - Instrument loads provided by IOCs



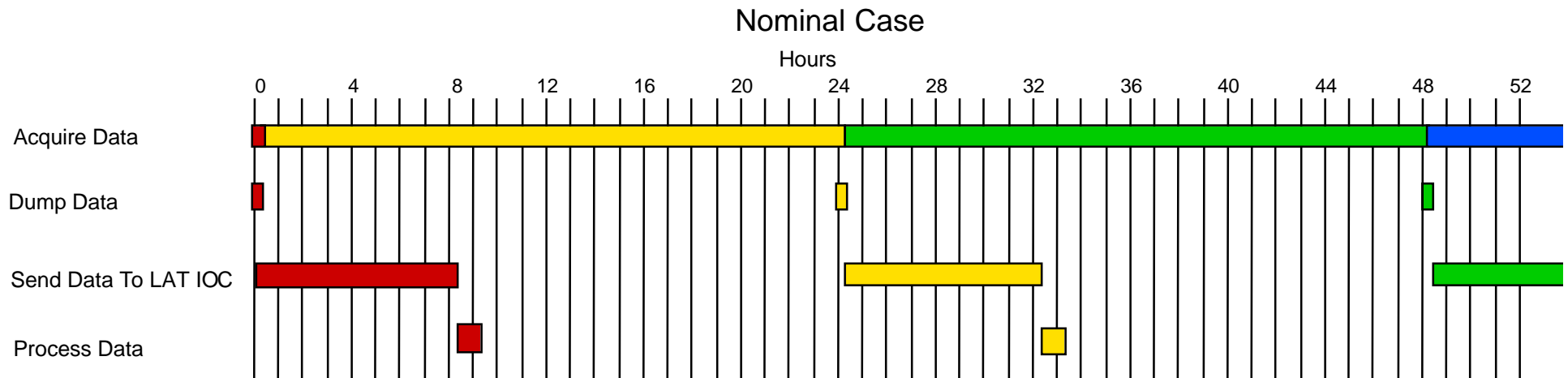
Routine Operations (continued)

- **Health and Safety Telemetry**
 - Mission Operations Center responsible for observatory safety and spacecraft health
 - Instrument Operation Centers responsible for instrument health
 - Spacecraft provider will be responsible for sustaining engineering for at least a few years
- **Science Data Processing**
 - Instrument Operations Center generate standard products
 - SSC also generates some standard products
 - SSC responsible for archiving data for duration of mission
 - Archive transferred to HEASARC by the end of the mission



Data Delivery Delays

- **Oldest data delivered to the LAT IOC can be 24 to 50 hours old**
- **Onboard detection and use of TDRSS alert service for transients with time scales of a day or less**





Data Loss

- At least 98% of the data generated by the instruments is required to be delivered to the Instrument Operations Centers
- 2% data loss limits allows low cost operations
- Primary sources of data loss are problems during operations
 - Ground station hardware/software hiccups
 - Misconfigurations
 - Inconsistent information among the spacecraft, MOC, and ground station
- Large losses of data (e.g., a full pass) will be recovered
- Modest losses (e.g., less than a minute of downlink) will not be recovered if an additional contact would be required
- 2% loss allowance will be averaged over a month



Special Operations

- **Launch and early orbit**
 - TDRSS used to monitor critical events
 - Additional ground station contacts
 - Spacecraft checkout, instrument checkout, and the exercise of the survey, inertial pointing, and pointed scan observation mode
 - Nominal operations shall begin 30-60 days from launch
- **End of mission**
 - Controlled reentry (TBR)
- **Targets of Opportunity**
 - Observation of a short term phenomenon discovered by another observatory that is interesting enough to interrupt planned GLAST observations
 - Determination made by project scientist (or designee)
 - Observation will begin within hours of determination
 - TDRSS Forward link will be used to command new observation
 - Frequency expected to be less than once per month



Special Operations (continued)

- **Anomalies and Safe Mode Recovery**
 - Spacecraft notifies Mission Operations Center via TDRSS demand access service
- **Software loads**
 - Large software loads to the LAT will be done through TDRSS
- **LAT raw data mode**
 - Onboard software filters will be disabled, significantly increasing data rate
 - Extra contact will be scheduled to dump solid state recorder



Staffing

- **SSC and IOCs expected to be staffed 8 hours per day/5 days per week for normal operations**
- **MOC staffing depends on selection of MOC provider**
 - If unstaffed:
 - MOC staff will be on call in the event of a safety alert from the spacecraft or the MOC
 - Unstaffed commanding for targets of opportunity will be explored
- **Additional staffing for launch and initial checkout**
 - MOC expected to be staffed around the clock through spacecraft checkout
 - IOCs will be staffed around the clock to support instrument checkout